

# ADERSA

---

## MELISSA

Memorandum of Understanding  
ECT/FG/MMM/97.012

ESTEC/Contract N° 12924/98/NL/MV  
Contract change notice No 03 of August 2001

## TECHNICAL NOTE : 64.1

Upgrading the programmes  
of the global simulator

Version : 1  
Issue : 0

J.-J. LECLERCQ

August 2002

10, rue de la Croix Martre  
91873 PALAISEAU Cedex  
Téléphone : (33) 1 60 13 53 53  
Télécopie : (33) 1 69 20 05 63  
Courriel : [adersa@adersa.com](mailto:adersa@adersa.com)



## Document Change Log

<b>Version</b>	<b>Issue</b>	<b>Date</b>	<b>Observation</b>
0	0	August 2002	Draft
1	0	August 2002	Original version

<b>ESA-ESTEC</b>	<b>MELISSA - Technical Note 64.1</b> <b>"Upgrading the programmes of the global simulator"</b>		August 2002
ADERSA	10, rue de la Croix Martre 91873 PALAISEAU Cedex	Tel : (33) 1 60 13 53 53 E-Mail : adersa@adersa.com	Fax : (33) 1 69 20 05 63 Page 2

## TABLE OF CONTENTS

1. INTRODUCTION.....	4
2. METHOD FOR THE MODIFICATIONS.....	4
3. RUNNING TIMES .....	4
3.1. Nitrite control. Comparison of running times for different integration methods.....	4
3.2. Nitrite control. Comparison of running times of the close loop system .....	5
4. REFERENCES.....	5

<b>ESA-ESTEC</b>	<b>MELISSA - Technical Note 64.1</b> <b>"Upgrading the programmes of the global simulator"</b>		August 2002
ADERSA	10, rue de la Croix Martre 91873 PALAISEAU Cedex	Tel : (33) 1 60 13 53 53 E-Mail : adersa@adersa.com	Fax : (33) 1 69 20 05 63 Page 3

# 1. INTRODUCTION

Since 1995 and so far, the simulation programmes were compliant with the version 4.2 of Matlab® and with the version 1.2 of Simulink®.

In this study, the programmes are upgraded with the version 5.3 of Matlab, which is the version used by the other partners of the MELISSA project.

All the programmes are now compliant with Matlab 5.3 and Simulink 3 (Release 11):

- global simulator;
- control of nitrite of the nitrifying compartment;
- control of Spirulina production;
- control of Rhodobacter production;
- dynamical behaviour of the 3 connected compartments 2,3 and 4a.

## 2. METHOD FOR THE MODIFICATIONS

A first upgrading has been done according to the information delivered in the chapter 3 of the Matlab book : Matlab 5.1 new features. Then Release 11 Enhancements have been applied, if any.

The Simulink function of a state system can no more be called from Matlab m.file: the S-function must now be placed within a Simulink block diagram model. The affected programmes have been re-coded for Simulink V3 compliance.

The gateway programme that interfaces Matlab to the C programmes (Spirulina or Rhodobacter production control) has been modified to be compliant with the new features of Matlab V5.3 . These modifications concern :

- the *mxArray* structure
- the type of data (real, complex, structure, cell or string) that are exchanged between the Matlab programme and the C programme.

## 3. RUNNING TIMES

### 3.1. Nitrite control. Comparison of running times for different integration methods

The following data have been obtained by running 'tst\_con' (test of control software) with three different ways of integration :

- 'ode45' (Matlab 4.2 and Matlab 5.3 method for non stiff problems);
- S\_function with 'gear' (Matlab 4.2) or 'ode15s' (Matlab 5.3);
- simple customized Euler method.

The type of test defined in 'i\_sim.m' is 'typtst=0'.

The values (running time expressed in seconds) of the tables 1 to 3 hereafter are mean values for 3 simulation horizons. Of course the simulation horizon is the same for all the methods and the simulations are run on the same computer.

ESA-ESTEC	MELISSA - Technical Note 64.1 "Upgrading the programmes of the global simulator"		August 2002
ADERSA	10, rue de la Croix Martre 91873 PALAISEAU Cedex	Tel : (33) 1 60 13 53 53 E-Mail : adersa@adersa.com	Fax : (33) 1 69 20 05 63 Page 4

### Matlab 'ode45'

Matlab V4.2 (s)	Matlab V5.3 (s)	ratio V5.3/V4.2
43.1	78.5	1.8

Table 1

### S\_function

Matlab V4.2 (s)	Matlab V5.3 (s)	ratio V5.3/V4.2
8.5	5.2	0.61

Table 2

### Customized Euler

Matlab V4.2 (s)	Matlab V5.3 (s)	ratio V5.3/V4.2
62.8	78.1	1.2

Table 3

### Conclusion

The running time is decreased only in the case of the S\_function. Fortunately and contrarily to the previous version of Simulink (V1.3), in the new one (Simulink V3), a S\_function can be called by a S\_function. So gain of running time can be obtained.

### 3.2. Nitrite control. Comparison of running times of the close loop system

In order to speed up the simulation, the calls to Matlab functions from Simulink have been replaced by Simulink equivalent functions ('selector' and 'gain' of Simulink to replace 'link\_con.m' written in Matlab code, for example) when possible.

The comparison is done for the 10 first hours (hour in process time) of the simulation of the closed loop system 'g\_simcl' with the first example of TN 64.4 (Step of flow rate requested by operator; figure 9 p. 15).

Thanks to these modifications and to the fact that an S-function can be called by another S-function, the running time of the closed loop system 'g\_simcl' is reduced in a ratio of 10 as seen in Table 4.

Matlab V4.2 (s)	Matlab V5.3 (s)	ratio V5.3/V4.2
685	70	0.10

Table 4

## 4. REFERENCES

Matlab Release 11 New Features. The MathWorks, Inc. January 1999.

Using Matlab. Version 5. The MathWorks, Inc. January 1999. Revised for Matlab 5.3 (Release 11).

ESA-ESTEC	MELISSA - Technical Note 64.1 "Upgrading the programmes of the global simulator"		August 2002
ADERSA	10, rue de la Croix Martre 91873 PALAISEAU Cedex	Tel : (33) 1 60 13 53 53 E-Mail : adersa@adersa.com	Fax : (33) 1 69 20 05 63 Page 5

Using Simulink. Version 3. The MathWorks, Inc. January 1999. Revised for Simulink 3 (Release 11).

Matlab Application Program Interface Guide. Version 5. The MathWorks, Inc. October 1998. Revised for Matlab 5.3 (Release 11).

<b>ESA-ESTEC</b>	<b>MELISSA - Technical Note 64.1</b> <b>"Upgrading the programmes of the global simulator"</b>		August 2002
ADERSA	10, rue de la Croix Martre 91873 PALAISEAU Cedex	Tel : (33) 1 60 13 53 53 E-Mail : <a href="mailto:adersa@adersa.com">adersa@adersa.com</a>	Fax : (33) 1 69 20 05 63 Page 6